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An Embedded Real-Time Finger-Vein Recognition System for Security Levels

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ABSTRACT: In this project, we discover a real-time embedded finger-vein recognition system for authentication on Security Level. Mainly the system is implemented on an embedded platform and equipped with a novel finger-vein recognition algorithm. The proposed system mostly consists of three hardware modules: image acquisition module, embedded main board, and human machine communication module. The first one image acquisition module is used to collect finger-vein images. The second embedded main board mostly include the Microcontroller chip, memory (flash) and the last one communication port is used to execute the finger-vein recognition algorithm.

Automated teller machines (ATMs) are used by individuals to carry personal and business financial transactions or banking functions. ATMs are found in many locations.

KEYWORDS: Finger vein recognition system, RFID module, embedded platform, communication module, image acquisition module.

I. INTRODUCTION

Now a day's security is very much important in all kind of activities at everywhere. Recently illegal activities are happening at lots of places, so government and corporate sections are concentrating on the security levels. This FVR system mainly uses three divisions. Each unit is having its own important role over the project. Here, two major areas have been focused and those are authentication and identification. Personal identification using finger vein patterns method extracted vein width and brightness fluctuation and equal error rate for personal identification found to be 0.0009% [3]. Every time when the user is going to use the system, the finger vein will be scanned and compare with user. Finger vein recognition is very effective when compared with pattern recognition. FVR system used for vein scanning. As it is related to the biological factor, it is not possible to change the vein information of a user. In this FVR system, we are focusing on high security with RFID technology. In this technology each and every user has one RFID secret card and this makes an effective communication between the user and the device. Fig. 1 will illustrate this feature.

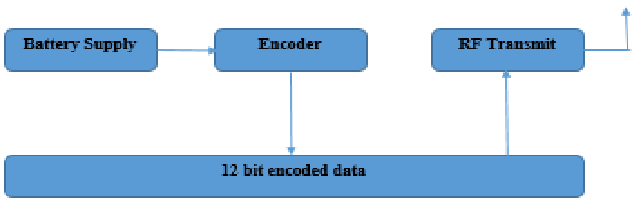

Fig.1: FVRS – Active secret card section

In FVR system, the RFID module is mostly used to collect the user data. With this system, a unique code will be generated for each and every user for storing the finger vein [7], [4] details in the server. The encoded signal will be continuously transmitted by the card if it is in on state. This RFID is used to reduce the complexity of the image acquisition module. So authentication and identification will become soon. Because of these features the FVRS will be a faster recognition system.

In the RF receiver module is attached with the embedded control unit. This unit receives the digital data from the card and gives to the controller. In this FVRS, vein images stored in the image acquisition module. If RF receiverreceives any digital code, then automatically verification of code will be done inside the embedded control unit.

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If the code is matched then an asynchronous commands given to the image acquisition [8], [4] module. Then the vein image compares inside the processor. The device will go to its working state, when the image is matched. With this GSM module we can develop the password system. The unit will send a password with this intimation. One-time password will be generated. Generally, this mobile GSM communication module will not only send the intimation for authorize but also for unauthorized. Fig. 2 will illustrate this feature.

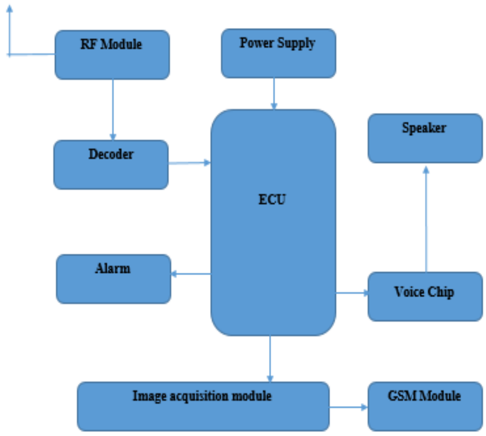

Fig. 2:FVRS – ATM Recognition unit

II. RELATED WORK

This project is used to improve the security level. An active RF method is used to provide a basic security and to the communication between the FVRS mobile device and the user. This card contains only a digital data which acts as a key to the image recognition unit. In FVRS, first mobile recognition unit checks the address bits which comes from transmitter section, if this address is matched then that corresponding data signal passed to the controller unit. Now this controller unit send a signal to the image acquisition unit to open the data base vein detail. For an easy identification, system is also merged in this unit. If any mismatch is found, then automatically the ECU will alert the entire system will start. At the same time intimation gives to the user's security number and this intimation is common for authentication. If any change in the FVRS - Mobile recognition unit, then the result is immediately transferred to the security number. And when the vein image is matched in the image acquisition module then One Time password will be send to the security number of the user. The user has to enter the particular password for further accessing. This will be more secured to user.

III. OVERVIEW OF THE FVRS UNIT

The FVRS – Mobile unit has the following important module section: Radio frequency identification system, image acquisition module, human machine communication module, embedded main board. In the existing module, there is a long list of available biometric patterns [9], [4] including the face, iris, fingerprint, palm print, hand shape, voice, signature, and gait. Human machine communication module. For example, fingerprints and palm prints are usually frayed, voice, signatures, hand shapes and iris images are easily forged; face recognition can be made difficult by occlusions or face-lifts and biometrics, such as fingerprints and iris and face recognition, are susceptible to spoofing attacks, that is, the biometric identifiers can be copied and used to create artifacts that can deceive many currently available biometric devices.

In the Proposed FVRS – Mobile recognition unit, Finger vein recognition (FVR) unit is used. The vein is hidden inside the body and is invisible to human eyes, so it is very difficult to forge or steal. The non-invasive and contactless capture of finger-veins ensures convenience and hygiene for the user, and more acceptable. The finger-vein pattern [6] can only identify from a live body. Therefore, it is a natural and convincing proof that the subject whose finger-vein is successfully captured is alive.

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IV. SYSTEM HARDWARE

A. ARM PROCESSOR

The ARM7 family mostly includes the ARM7TDMI, ARM7TDMI-S, ARM720T, and ARM7EJ-S processors. The ARM7TDMI core is the industry's widely used 32-bit embedded RISC microprocessor solution. The ARM7TDMI solution basically provides the low power consumption, small size, and high performance and embedded applications. The three-stage pipelining is used in ARM7TDMI core. If the processor having high speed it will make easily communication between the RF module and the Image acquisition module.

❖ **Operating modes**

The ARM7TDMI core has seven operating Modes:

- User mode is the usual program execution state
- Interrupt (IRQ) mode is used for general purpose interrupt handling
- Supervisor mode is a protected mode for the operating system

B. INTERRUPT CONTROLLER

The Vectored Interrupt Controller (VIC) generally accepts all of the interrupt request inputs and categorizes them in Fast Interrupt Request, vectored Interrupt Request, and non-vectored IRQ as defined by programmable settings and these interrupt settings gives a quick response to the RF decoder. So that address verification become very fast and image processing signal will be given to the image acquisition module.

C. WIRELESS COMMUNICATION

❖ **RF communication**

Radio Frequency

RF itself becomes synonymous with wireless and high-frequency signals. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on RF field propagation.

❖ **Transmitter**

TWS-434: The transmitter very small, used for short-range RF remote controls and this module do not incorporate internal encoding. The transmitter output is set up to 8mW at 433.92MHz with a range of approx. 400 foot (open area) outdoors. Indoors, the range is approximately 200 foot and which avoids obstacles.

❖ **RF receiver**

RWS-434: The receiver also operates at the range of 433.92MHz and has a sensitivity of 3uV. The WS-434 receiver operates on 4.5 to 5.5 volts-DC and has linear and digital both outputs. A 0 volt to VCC data output is available on pins. This output is normally used to drive a digital decoder IC or a microprocessor which is used to perform the data decoding. In instances, when no carrier is present the output will remain low. If we want to receive Simple control or status signals such as button presses or switch closes, we can use the encoder and decoder IC set.

❖ **GSM**

A GSM modem is mostly works with a GSM wireless network. GSM is nothing but Global system for mobile communication is a globally accepted standard for digital cellular communication. The GSM specifications mostly define the functions and interface requirements in details. The GSM network is mainly divided into three systems: Switching System (SS), Base Station System (BSS), and Operation and Support System (OSS).

GSM modems support set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, we can do things like:

- Reading, writing and deleting messages (SMS).
- Sending messages (SMS).
- Monitoring the signal strength.
- Monitoring the charging status and also check charge level of the battery.
- Reading, writing and searching phone book entries.

Sending the message:
To send the SMS message, type the following command:
AT+CMGS="+918793010024" <ENTER>
Replace the above phone number with your own phone number.

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Hello World! <CTRL-Z>
Here CTRL-Z is keyword for sending SMS through the mobile device. After some seconds the modem will respond with the message ID of the message, indicating that the message was sent correctly:
+CMGS: 62

V. IMAGE ACQUISITION

To obtain high quality NIR i.e. near-infrared images, a special device was developed for acquiring the images of the finger vein without affected by temperature. In General, finger-vein patterns can be imaged based on the principles of light reflection/transmission [9]. We developed a finger-vein imaging device based on light transmission. Finger-vein imaging device includes the following modules: a monochromatic camera has resolution 580 × 600 pixels, daylight cut-off filters (wavelength less than800 nm), transparent acryl i.e.10 mm thickness and the NIR light source. The structure of this Finger-vein imaging is illustrated in Fig. 5. The NIR light irradiates the backside of the finger. In [7], a light-emitting diode (LED) was used as the illumination source for NIR light. By using the LED illumination source, the shadow of the finger-vein appears in the captured images. To capture this problem, an NIR laser diode (LD) is used in our system. After comparison LED, LD has stronger permeability and higher power. In this device, the wavelength of LD is 808nm. Fig. 6 shows an example raw finger-vein image captured by using this device.

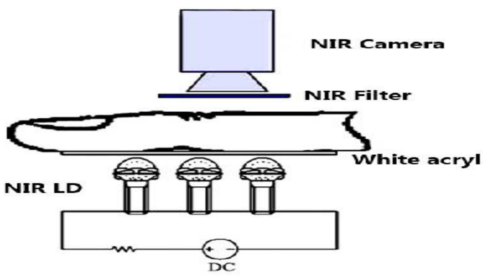

Fig.5:Illustration of the imaging device.

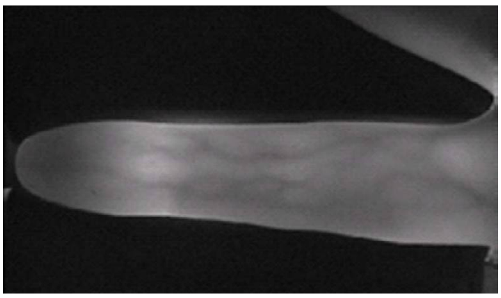

Fig. 6: An example raw finger-vein image captured by our device

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VI. DESIGN FLOW

The flow diagram of FVRS- Mobile unit is shown in fig.7.This flow diagram shows the step by step function of finger vein recognition system. At the beginning device will wait for an RF signal to activate the communication between the unit of embedded control and the image acquisition. After that the finger vein image of the user is compared with the fixed and unique data base. Then the authentication result send to the security number of the user. At the starting take the image from the data base then resize it into 1/3 size for low noise image and then use histogram for the enhancement of the image and compare that image with user and database. If not compared, then security number is get from mobile and if image is compared then security number is from the mobile through voice alert.

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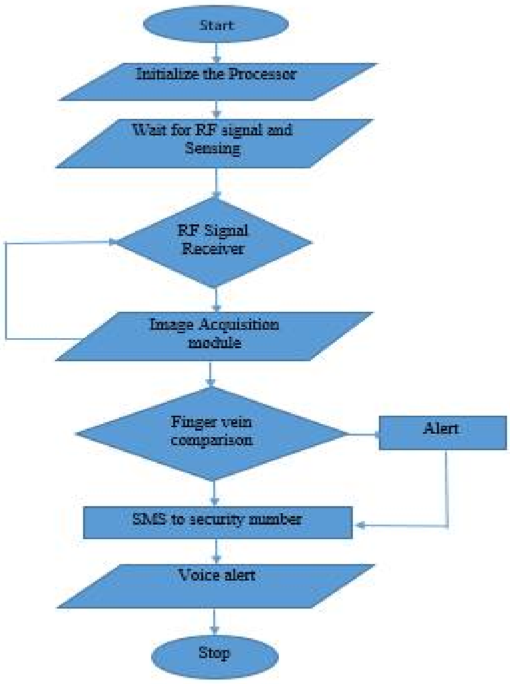

Fig. 7:Flow diagram of FVRS

VII. EXPERIMENTAL RESULTS

Dataset

To the best of our knowledge, is no public finger-vein image database has yet been introduced. Therefore, we constructed a finger-vein image database for evaluation, which contains finger-Vein images from 100 subjects (55% male and 45%female) from a variety of ethnic/racial ancestries. The ages of the subjects were between 21 years old and 58 years old. We collected finger-vein images from the forefinger, middle finger, and ring finger of both hands of each subject. Ten images were captured for each finger at different times (summer and winter). Therefore, there were a total of 6,000finger-vein images in the database. Fig. 9 shows some example finger-vein images (after pre-processing) from different fingers.

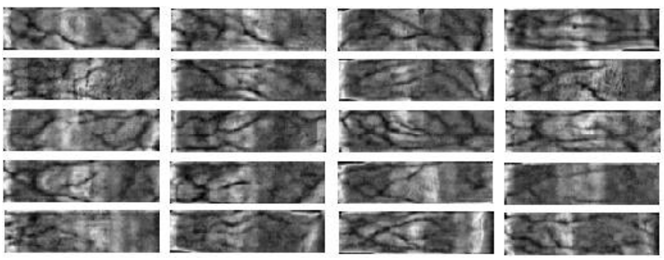

Fig. 8: Finger-vein images from different fingers after pre-processing

Comparison with Previous Methods

A database that contained 678 different infrared images of fingers. These images were obtained from persons working in their laboratory aged 20 to 40, approximately 70% of whom were male. Finger-vein image dataset contained 1,125 images collected using an infrared imaging device they built. Nine images were taken for each of 125 fingers. Compared with these databases, ours is larger and the data-collection interval is longer. Thus, our database is more challenging. Moreover, our system is implemented on a general DSP chip. Table 1 shows that the average times required for feature extraction and matching in our system are 343 ms and 13 ms, respectively. For the whole system, plus the time for image capturing, the time required for the authentication of a user is less than 0.8 s. Although the

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feature extraction in our system is a little bit more complicated than that in Song's method, our system achieves an EER of 0.07%, indicating that our method significantly outperforms previous methods.

TABLE 1
RECOGNITION RATE AND RESPONSE TIME

Method	Sample number #finger (*#image per finger)	EER (%)	Time	
			Feature extraction	Matching
Our method	600(*10)	0.07	343 ms	13 ms
Miura's method [19]	678(*2)	0.145	450 ms	10 ms
Song's method [20]	125(*9)	0.25	118 ms	88 ms

VIII. CONCLUSION

Security is becoming very much essential in all kind of applications. As the finger-vein is a promising biometric pattern for personal identification in terms of its security and convenience. Also the vein is inside the body which is in hidden condition and is invisible to human eyes, so it is difficult to forge or steal. This system is more hopeful in improving the security level.

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